WHAT IS CLAIMED IS:

1. A semiconductor device comprising:

a semiconductor substrate;

a porous insulating film formed above said semiconductor substrate, said porous insulating film having a relative dielectric constant of 2.5 or less and including a first insulating material, at least a portion of pores in said porous insulating film having on the inner wall thereof a layer of a second insulating material which differs in nature from said first insulating material; and

a plug and/or a wiring layer buried in said porous insulating film.

2. The semiconductor device according to claim 1, wherein said pores having a layer of a second insulating material on the inner walls thereof has a maximum diameter of 3 nm or less.

3. The semiconductor device according to claim 1, wherein said first insulating material comprises an organic component, and said second insulating material comprises a silicon oxide.

4. The semiconductor device according to claim 1, wherein said first insulating material is selected from the group consisting of polyarylene, polyarylene polyether, methylsilsesquioxane and polymethylsiloxane.

5. The semiconductor device according to claim 1, wherein said plug and/or wiring layer is formed of a Cu

layer having a barrier metal film on their surfaces.

6. A semiconductor device comprising:

a semiconductor substrate;

a porous insulating film formed above said semiconductor substrate and having a relative dielectric constant of 2.5 or less, an average diameter of pores in said porous insulating film being smaller in a surface region of said porous insulating film than in an inner region of said porous insulating film; and

a plug and/or a wiring layer buried in said porous insulating film.

7. The semiconductor device according to claim 6, wherein said pores of said porous insulating film have an average diameter which is relatively small in the vicinity of said plug and/or wiring layer and is relatively larger at a region away from said plug and/or wiring layer.

8. The semiconductor device according to claim 6, wherein said porous insulating film contains at least one material selected from the group consisting of polyarylene, polyarylene polyether, methylsilsesquioxane and polymethylsiloxane.

9. The semiconductor device according to claim 6, wherein said plug and/or wiring layer is formed of a Cu layer having a barrier metal film on their surfaces.

10. A method for manufacturing a semiconductor device comprising:

forming a porous insulating film above a semiconductor substrate, said porous insulating film having a relative dielectric constant of 2.5 or less;

forming a recessed portion on a surface of said porous insulating film; and

filling said recessed portion with a conductive material to form a plug and/or a wiring layer;

wherein prior to filling said recessed portion with said conductive material, said porous insulating film is placed inside a chamber to expose said porous insulating film to an oxidizing gas flow and a reducing gas flow which have been alternately introduced into said chamber, to take place an oxidation-reduction reaction in said porous insulating film, thereby forming a layer of a reaction product on the inner wall of pores of said porous insulating film.

11. The method according to claim 10, wherein said pores in said porous insulating film formed above said semiconductor substrate has a maximum diameter of 4 nm or more.

12. The method according to claim 10, wherein said oxidizing gas contains at least one selected from the group consisting of O_2, N_2O, Cl_2, F_2, O_3 and WF_6.

13. The method according to claim 10, wherein said reducing gas contains at least one selected from the group consisting of SiH_4, H_2 and HF.

14. The method according to claim 10, wherein

forming a layer of reaction product onto the inner wall of the pores of said porous insulating film is performed subsequent to forming a recessed portion on said porous insulating film.

15. The method according to claim 10, wherein said porous insulating film contains an organic component and said reaction product contains a silicon oxide.

16. The method according to claim 10, wherein filling said recessed portion with a conductive material to form a plug and/or a wiring layer includes depositing a Cu layer through a barrier metal film.

17. A method for manufacturing a semiconductor device comprising:

forming a porous insulating film above a semiconductor substrate;

forming a recessed portion on a surface of said porous insulating film; and

filling said recessed portion with a conductive material to form a plug and/or a wiring layer;

wherein said porous insulating film is irradiated with electron beam to enlarge the size of pores of said porous insulating film.

18. The method according to claim 17, wherein said pores of porous insulating film formed above said semiconductor substrate has an average diameter of 1 nm or less.

19. The method according to claim 17, wherein

enlarging the size of said pores through irradiation of electron beam onto said porous insulating film is performed subsequent to filling said recessed portion with a conductive material.

20. The method according to claim 17, wherein filling said recessed portion with a conductive material to form a plug and/or a wiring layer includes depositing a Cu layer through a barrier metal film.